

5-27-2011

# Ocular Coherence Tomography Guide

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## Recommended Citation

Reed, Brandon; Glabe, David; and Yudcovitch, Lorne, "Ocular Coherence Tomography Guide" (2011). *Faculty Scholarship (COO)*. Paper 12.  
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# Ocular Coherence Tomography Guide

**Description**

A basic guide of ocular coherence tomography (OCT) images of several common retinal conditions, with interpretation. This guide is primarily for clinical reference use by interns and doctors, as well as a student resource.

**Keywords**

Ocular coherence tomography, OCT, retina, macula, scan

**Disciplines**

Optometry

**Comments**

This guide was a student Master of Science in Vision Science project by Pacific University College of Optometry (COO) students Brandon Reed (2012) and David Glabe (2012), under the supervision and contributions/edits of COO faculty Dr. Lorne Yudcovitch.

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# Optical Coherence Tomography

A Clinician's Guide to Retinal Scan Interpretation



by  
Brandon Reed, B.S. & Dave Glabe, B.S.  
Advisor: Lorne Yudcovitch, O.D., M.S., F.A.A.O

### **Dedication:**

This guide is dedicated to optometric educators like Lorne Yudcovitch, OD, MS, FAAO, whose countless hours of devotion to the training of the next generation of primary eye care physicians has not gone unnoticed nor unappreciated.

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## Introduction

The technology of OCT provides an unparalleled clinical tool for the identification and management of retinal pathology. OCT is often explained as being similar to an ultrasound procedure, but with coherent light rather than sound as the medium of information. OCT images are generated by measuring the reflectance of light from translucent materials such as the retina. This information is processed by a computer, and artificially colored based on the degree of reflectance. Standard convention is to color the image with a spectrum ranging from red (white if black and white) for the most reflective tissues, to green (black if black and white) for the least reflective tissues.

Although spectral-domain (SD) OCT technology permits 3-dimensional imaging of tissue by combining hundreds of nearly instantaneous laser scans, each scan is performed in a single plane, permitting a cross-sectional view of structures. In the retina, this allows visualization of each unique layer, as shown below for a normal eye.

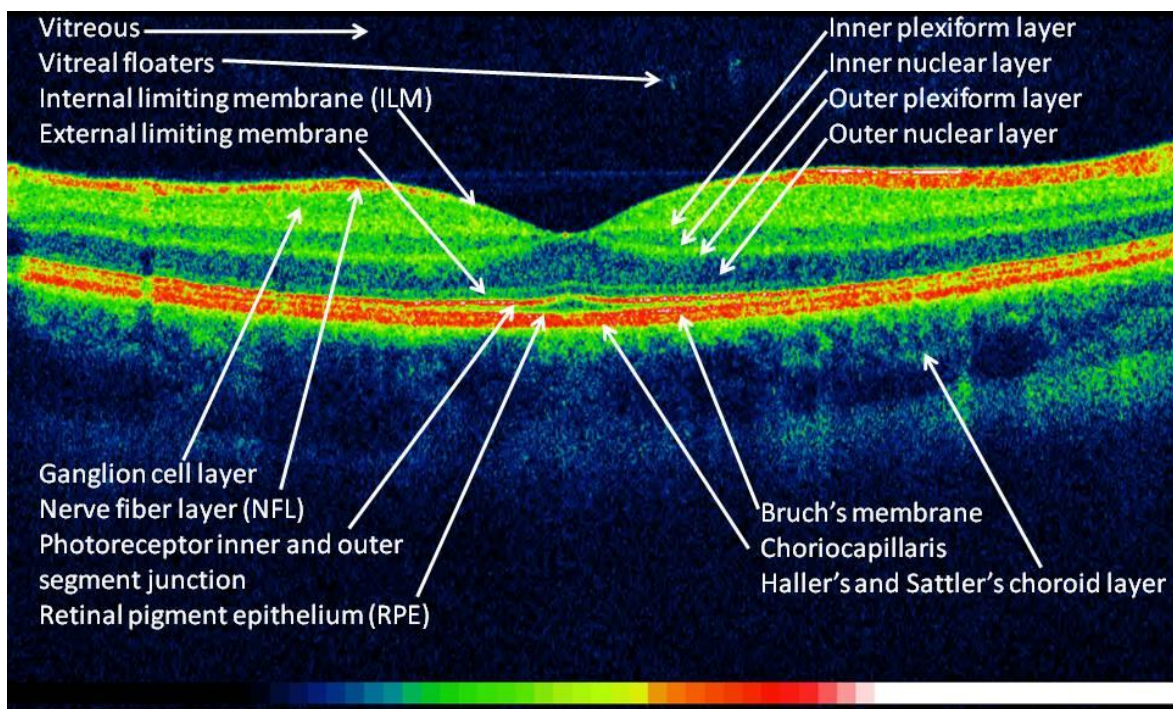
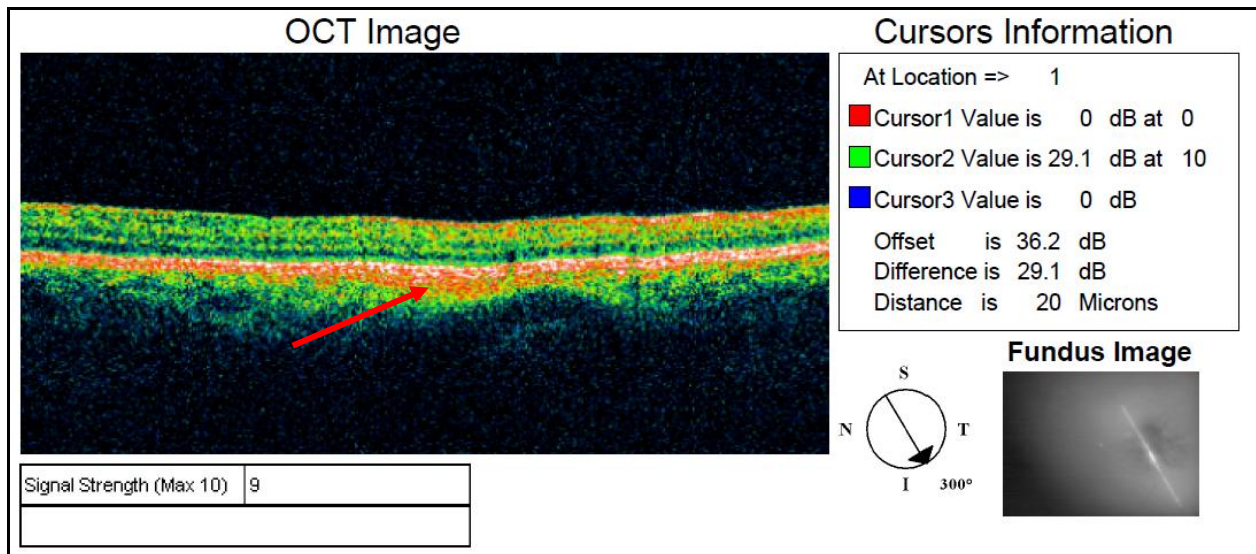


Image courtesy Dr. Lorne Yudcovitch

This guide is meant to serve as a basic reference to familiarize the clinician with some of the most commonly seen retinal pathologies viewed by OCT, as well as the most prevalent imaging artifacts seen on OCT that may be misinterpreted as pathology. Section 1 addresses OCT appearances of various common pathologies, including brief discussion of the pathological features and differential diagnoses; common scan artifacts are covered in Section 2. Individual topics are arranged alphabetically.

## Section 1: OCT Scans of Common Retinal Pathologies

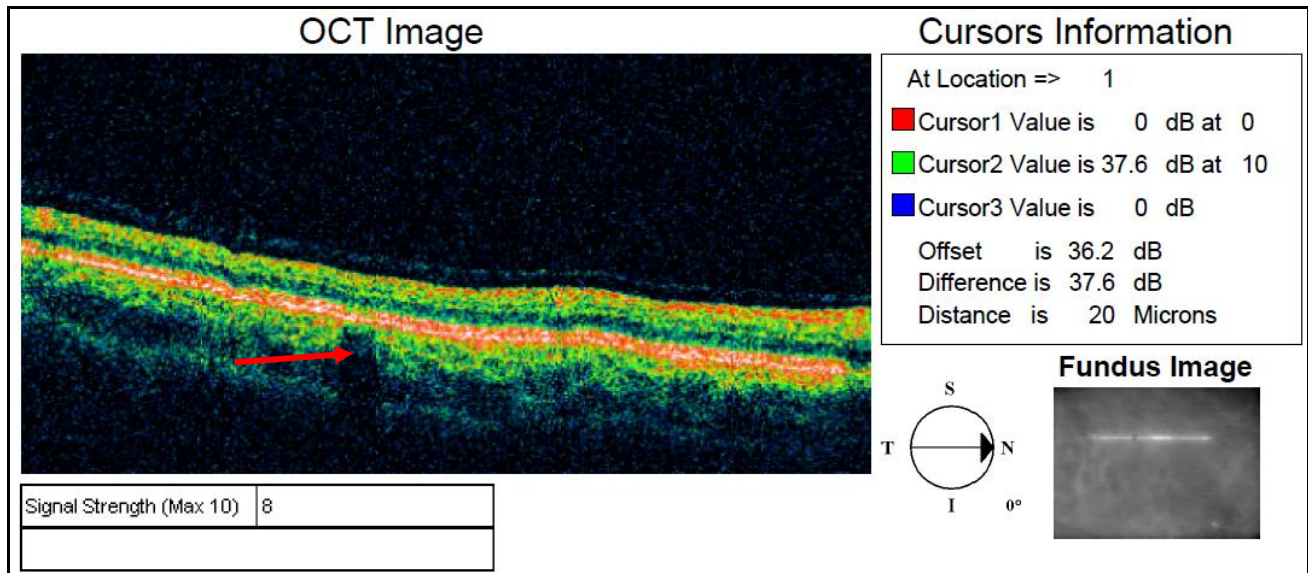
### Benign Choroidal Neoplasia (Nevus):



OCT may be helpful in the differentiation of benign from malignant choroidal neoplasias by permitting visualization of the depth of the lesion. Malignant lesions tend to be raised, and frequently show secondary retinal changes such as an overlying serous retinal detachment, intraretinal splitting between layers, cystoid spaces, or RPE abnormalities of hyper-reflectance similar to drusenoid deposits. A flat lesion is more likely to be benign, although all factors must be considered in order to rule out malignancy.

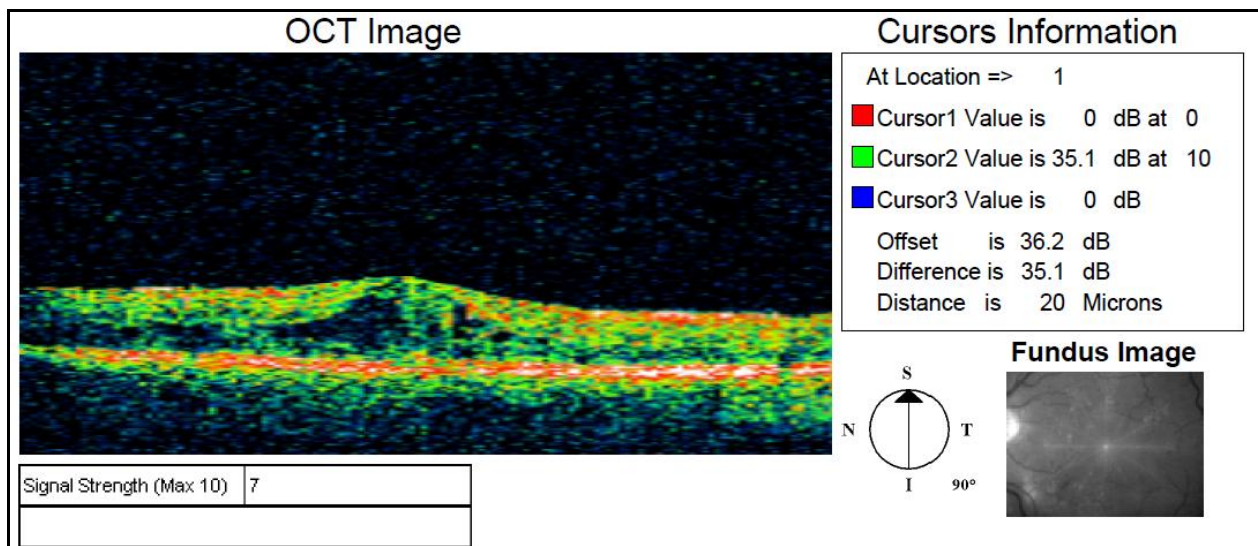


## Congenital Hypertrophy of the Retinal Pigment Epithelium (CHRPE)

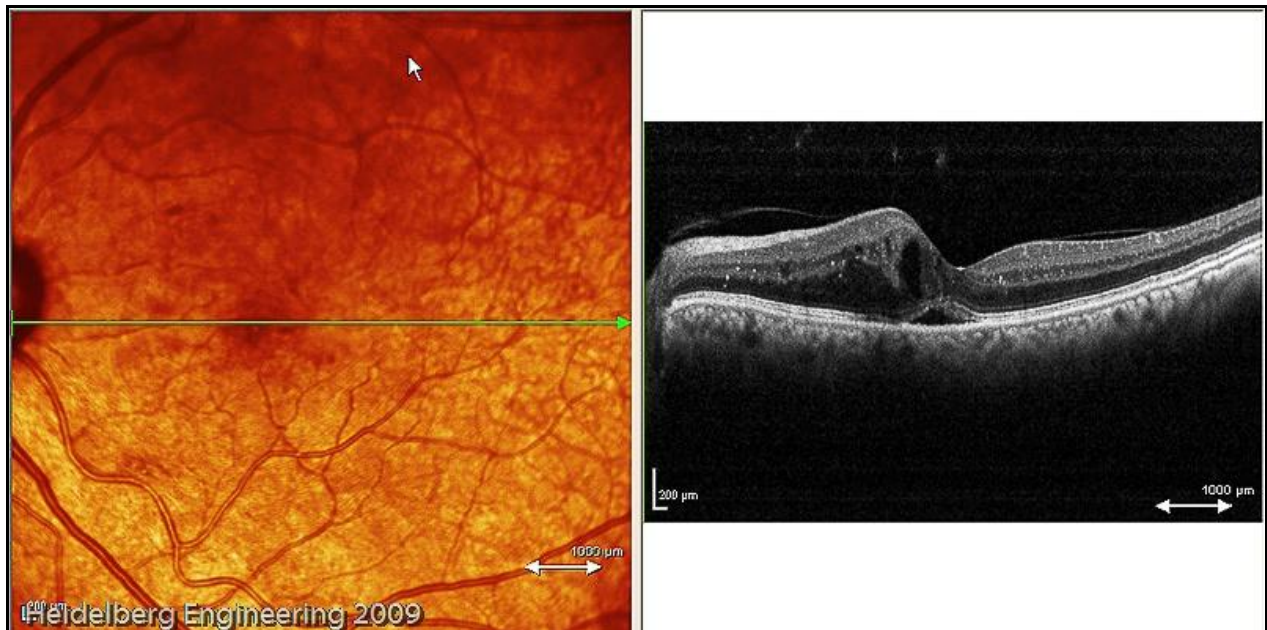


CHRPE appears as an isolated flat (or very slightly thickened) RPE area on the OCT image that may cause optical shadowing that obscures underlying tissues. CHRPE must be differentiated from choroidal melanoma, which occurs beneath the RPE layer, may be raised, and may change over time.

## Clinically Significant Macular Edema (CSME)/Diabetic Retinopathy







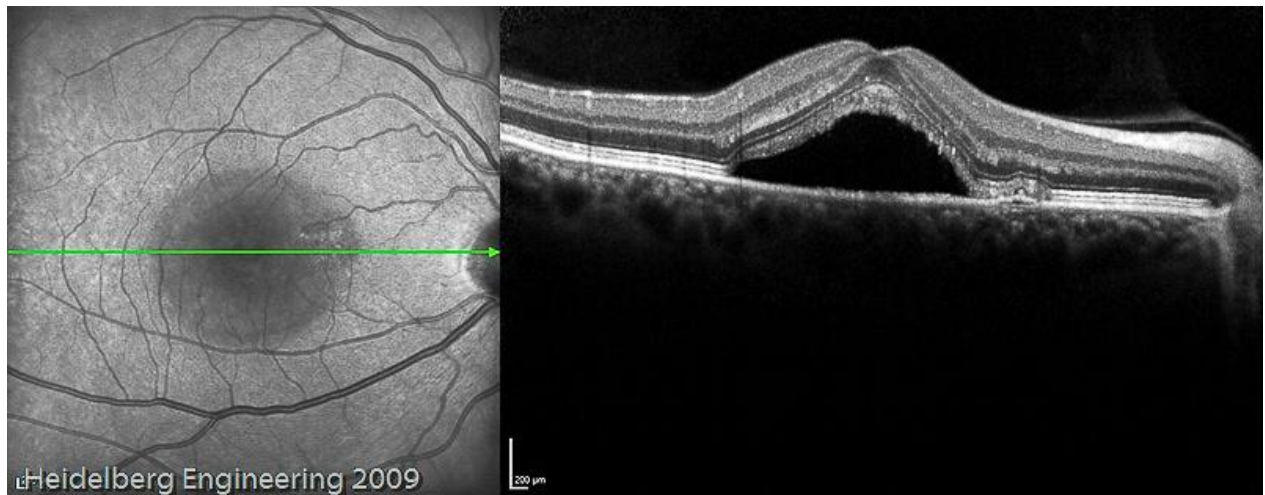
<http://www.retinarevealed.com/>

CSME is caused by an accumulation of fluid in the layers of the retina secondary to diabetic tissue alterations. An OCT image of a normal macula will show a symmetrical foveal depression and is easily distinguished from the hump shape caused by edema. Notice the characteristic intraretinal area of low reflectivity.

#### Clinically Significant Macular Edema as defined by the ETDRS

- Retinal thickening within 500  $\mu\text{m}$  of the center of the fovea.
- Hard, yellow exudates within 500  $\mu\text{m}$  of the center of the fovea with adjacent retinal thickening.
- At least 1 disc diameter of retinal thickening, any part of which is within 1 disc diameter of the center of the fovea.

## Central Serous Chorioretinopathy



<http://www.retinarevealed.com/>

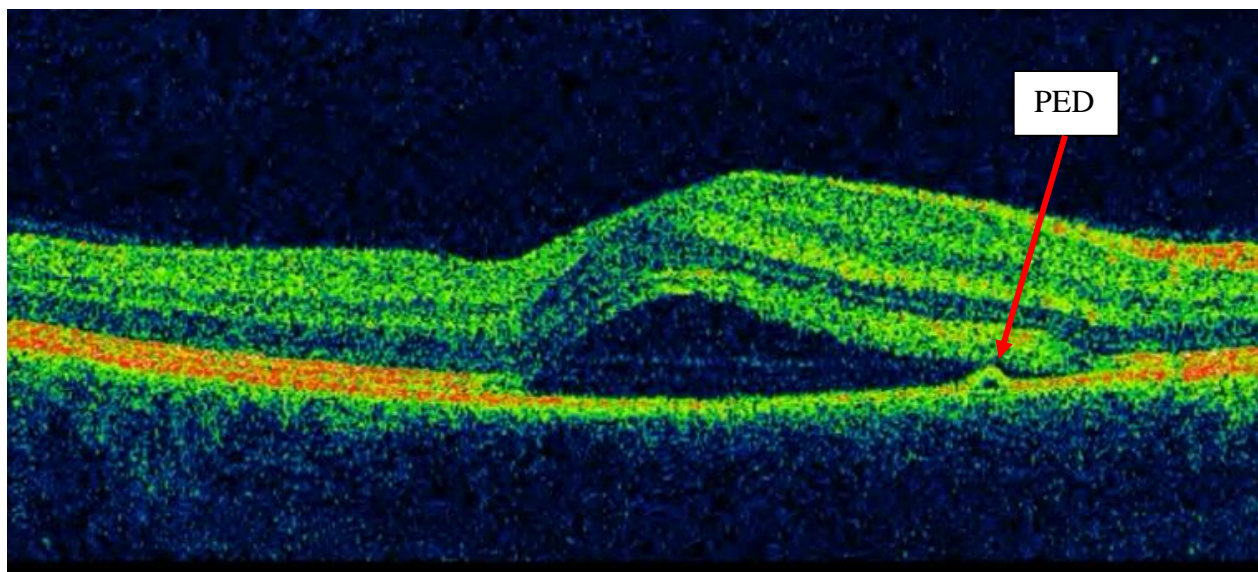


Image courtesy Dr. Lorne Yudcovitch

Central Serous Chorioretinopathy is caused by leakage of fluid from the choriocapillaris under the RPE, into subretinal spaces, or both through a pigment epithelial detachment (PED). Although idiopathic, the problem appears to be with the RPE or choroid not functioning properly. The textbook patient for this condition is a Type 'A' personality male (20-45 YO) with sudden onset vision loss and metamorphopsia (most commonly micropsia due to increased separation of the photoreceptors).

## Cystoid Macular Edema

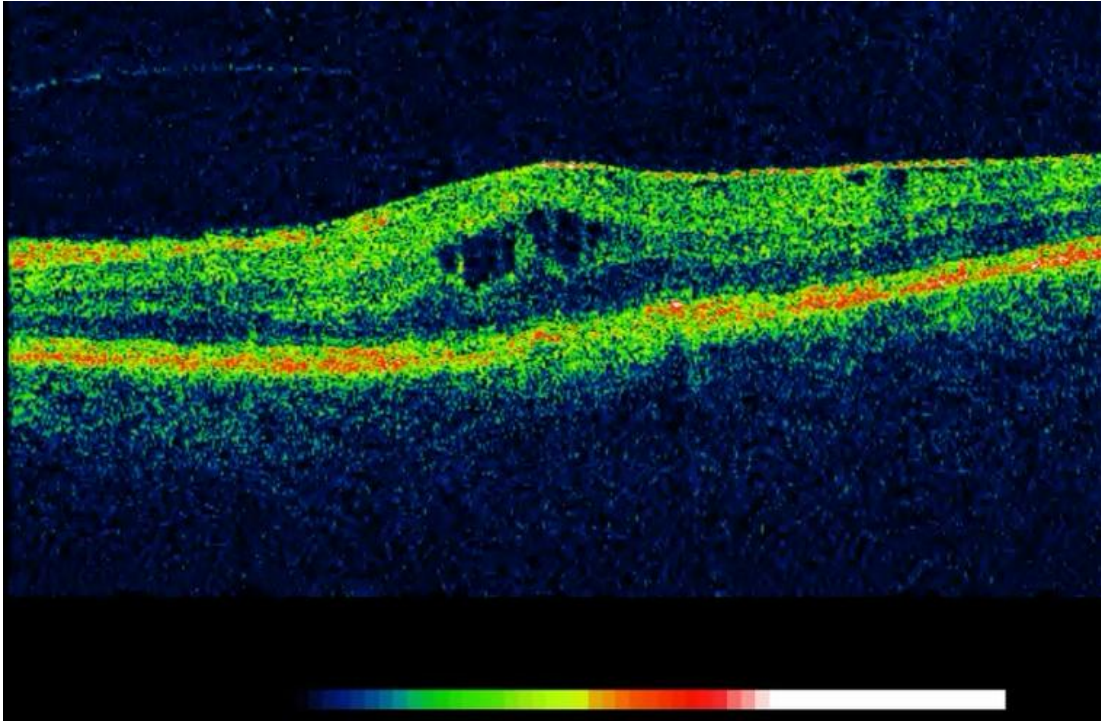


Image courtesy Dr. Lorne Yudcovitch

Cystoid macular edema is characterized by multiple cystic spaces beneath the macula that result in a painless loss of visual acuity or metamorphopsia. Although the exact cause is unknown, this condition most commonly occurs in post-operative cataract patients within 6-10 weeks after surgery, and may also be seen in diabetes, uveitis, and retinal vein occlusion. OCT imaging allows direct visualization of the cystic retinal spaces and immediate diagnosis of this condition, and is a powerful tool for monitoring its resolution.



## Drusen of the Optic Disc

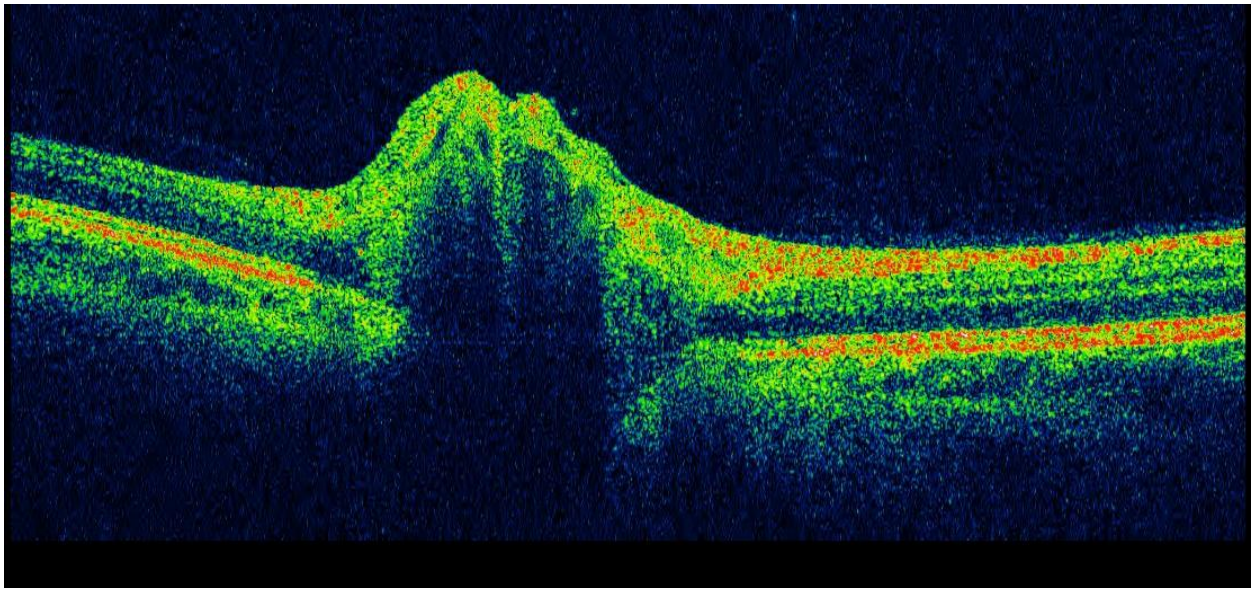
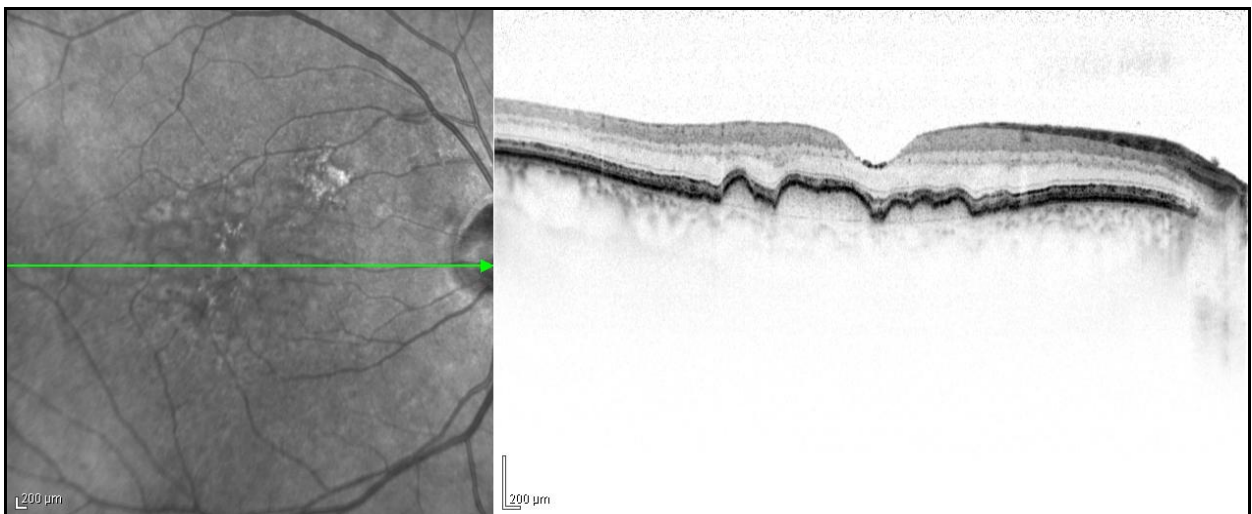


Image courtesy Dr. Lorne Yudcovitch

Optic disc drusen are a highly reflective hyaline-like material found in the optic disc that displaces nerve fibers, leading to loss of visual field. This relatively common condition may be autosomally inherited, and tends to be progressive throughout life. OCT is a useful instrument to monitor disc drusen and changes in the retinal nerve fiber layer, allowing visualization of some drusen that may not be evident on fundus examination. Disc drusen appear as elevated or thickened areas of the disc tissue on OCT imaging.

## Drusen of the Retina



[http://upload.wikimedia.org/wikipedia/commons/a/ad/Drusen\\_in\\_OCT.png](http://upload.wikimedia.org/wikipedia/commons/a/ad/Drusen_in_OCT.png)

Retinal drusen form as an accumulation and aggregation of lipofuscin waste products of the RPE and photoreceptors at the layer of Bruch's membrane. Drusen are most commonly seen in atrophic retinal disease such as age-related macular degeneration, although they may be seen in relatively benign conditions such as dominant familial drusen. OCT permits visualization of the drusen beneath the RPE layer as hyper-reflective (red) "mounds" that may displace the retinal tissue when large. OCT may be used to follow progression of small to large drusen over the course of a disease.

### **Epiretinal Membrane (Macular Pucker or Cellophane Maculopathy)**

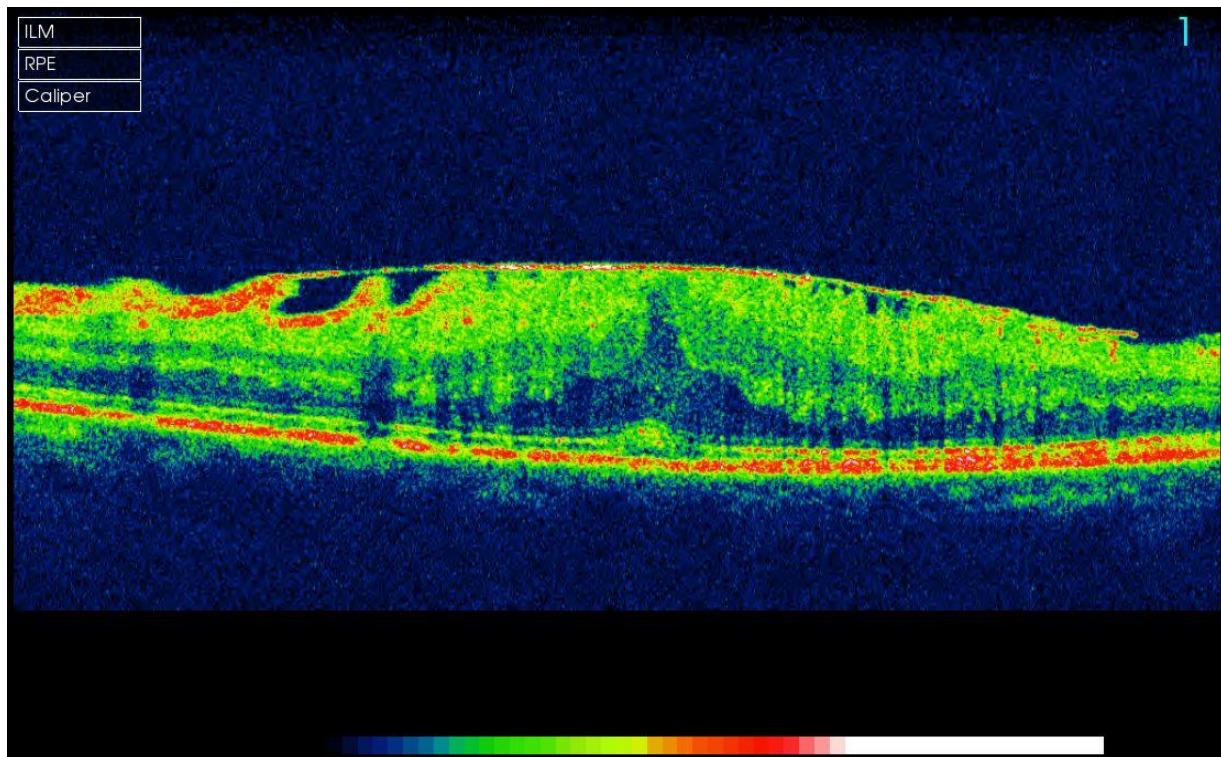


Image courtesy Dr. Lorne Yudcovitch

Epiretinal membranes occur due to proliferation of glial tissue in the retinal nerve fiber layer (NFL) along with vitreoretinal interface changes. This tissue often results in abnormal displacement of the internal limiting membrane (ILM) as well as more outer retinal layers, and may cause a corresponding decrease in visual acuity and metamorphopsia. On OCT imaging, epiretinal membrane appears as an uneven inner surface of the retina, often with cystic gaps between NFL and ILM. Epiretinal membranes sometimes simulate macular holes (termed macular pseudohole), but will lack abnormalities in deeper retinal layers characteristic of true macular holes.



## Lamellar Hole

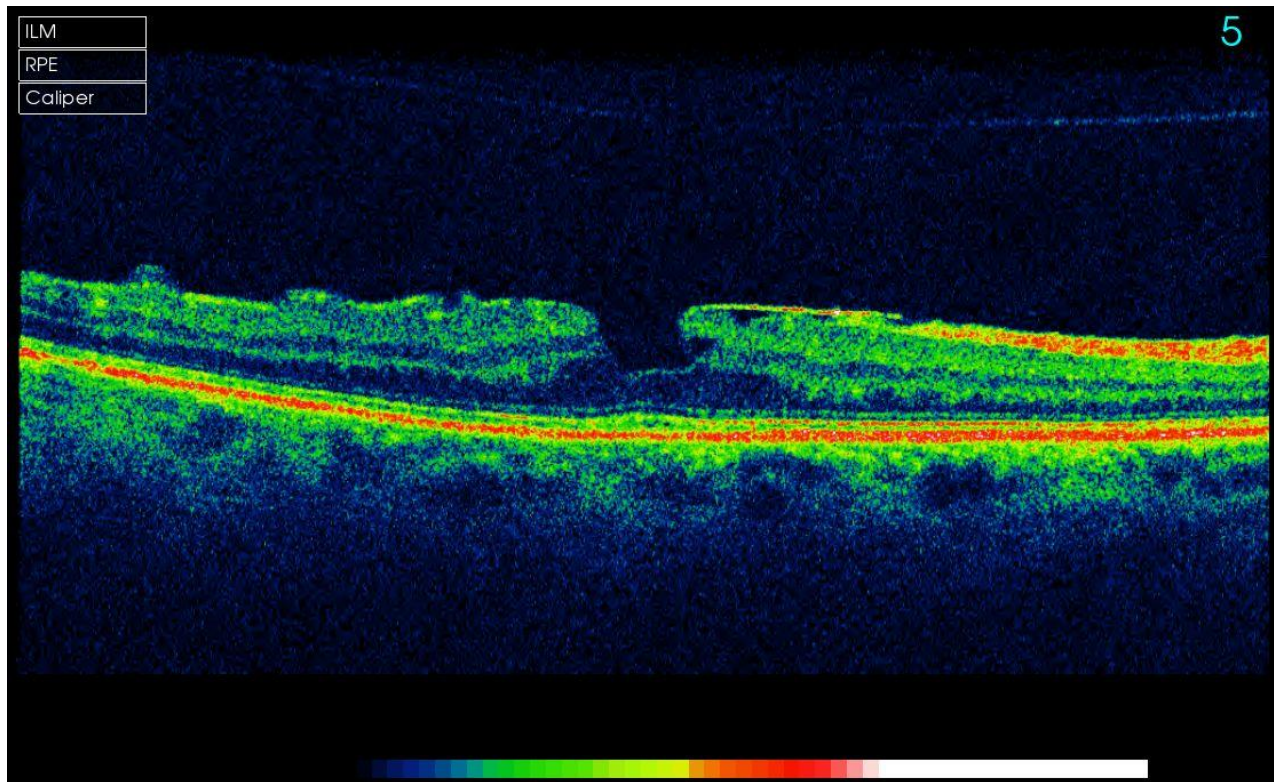


Image courtesy Dr. Lorne Yudcovitch

A lamellar hole is closely related to a macular hole, but may be distinguished on OCT by the presence of retinal tissue at the base and a characteristic reverse “anvil” or dumbbell shape. Lamellar holes may vary in size significantly.

## Macular Hole



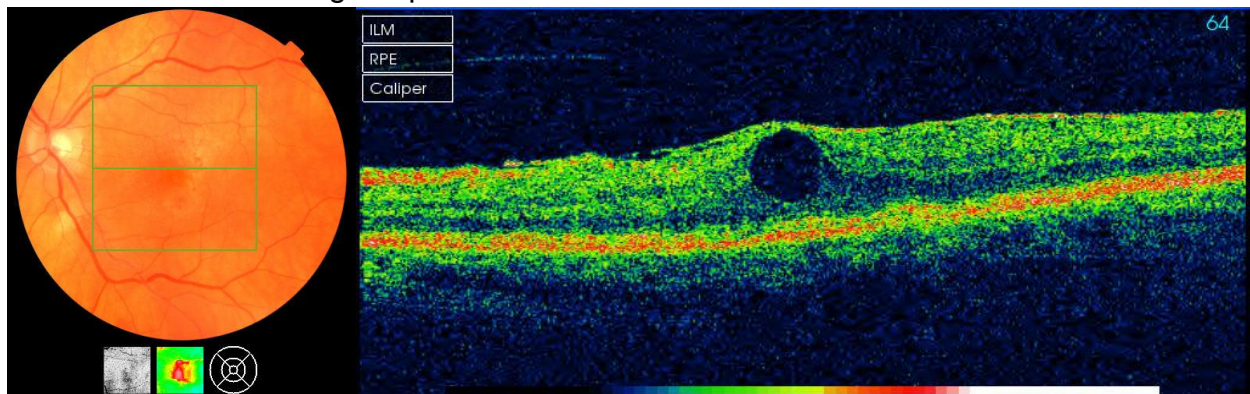
Macular hole with surrounding vitreoretinal fibrosis

Image courtesy Dr. Lorne Yudcovitch



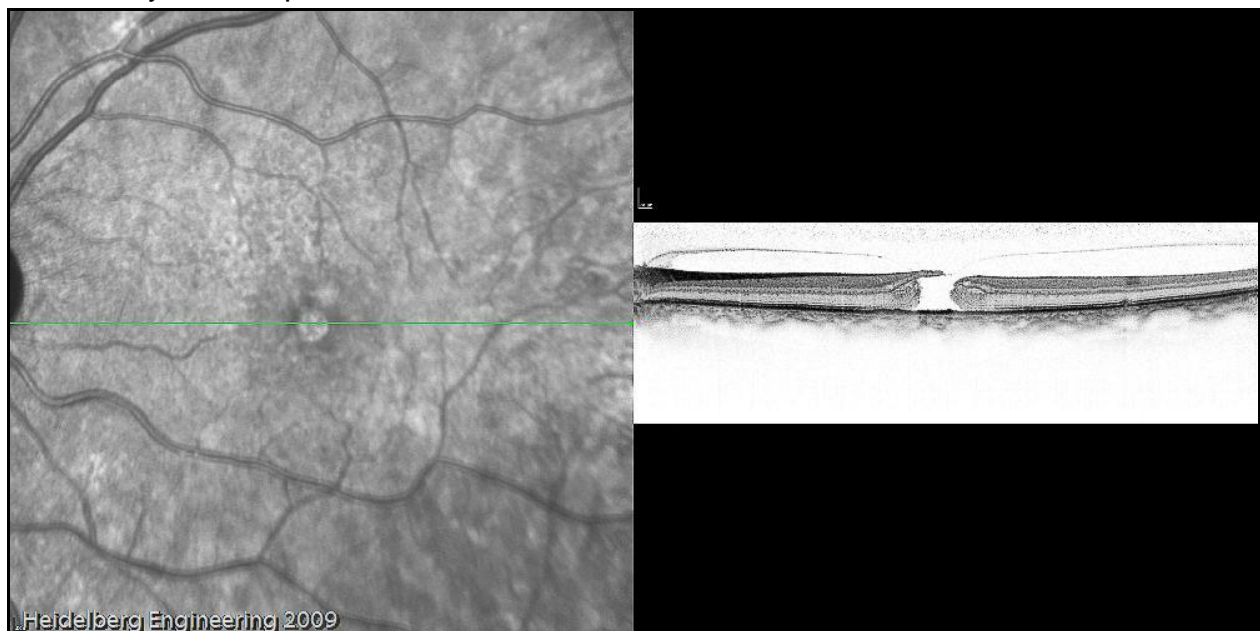
Macular holes are generally idiopathic, although most specialists agree that vitreoretinal traction on the macula is responsible for the lesion. Macular holes may be difficult to identify by fundus photography or standard posterior pole examination. OCT is a critical component in the identification of a macular holes and diagnosis of their severity and prognosis. OCT alone may allow visualization and differentiation of all four stages of macular hole.

Stage 1: Seen as a decreased or absent foveal depression on OCT, often with underlying cystic space. Fundus examination may reveal a yellowish foveal ring or spot.



Stage 1 Macular Hole  
Image courtesy Dr. Lorne Yudcovitch

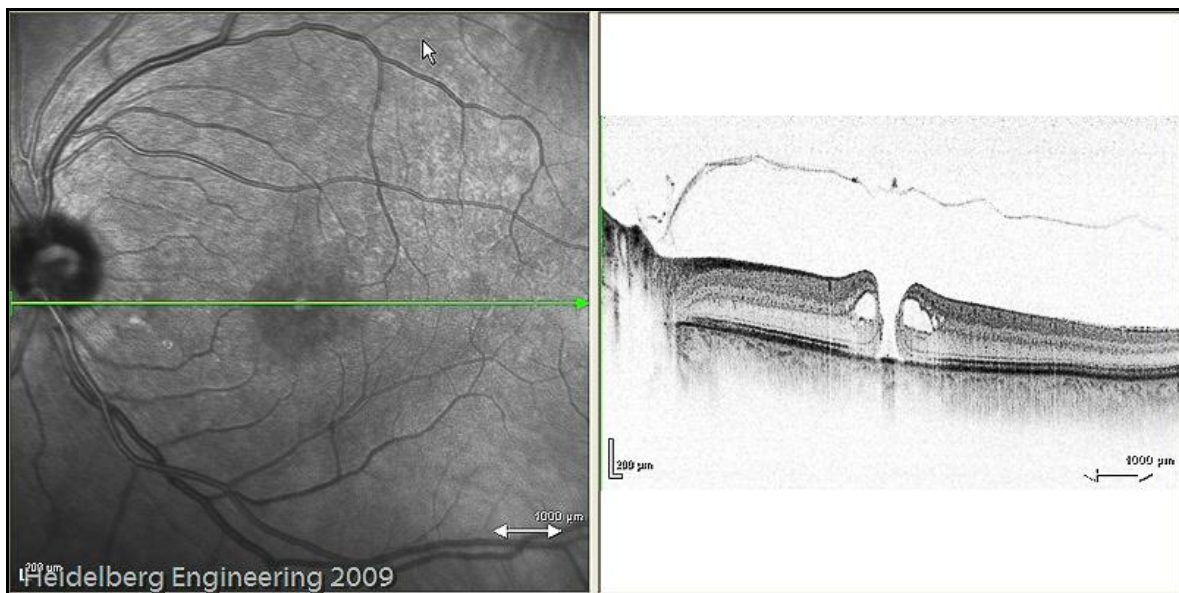
Stage 2: A small, full-thickness hole may be visualized on OCT. A tangential tear may also be present.



Stage 2 Macular Hole  
<http://www.retinarevealed.com/>

Stage 3: full-thickness hole without PVD.

Stage 4: Full-thickness hole with fluidic cuff and complete PVD.



Stage 4 Macular Hole

<http://www.retinarevealed.com/>

An operculum may or may not be seen above late-stage macular holes, and tends to decrease in size with time.

### Posterior Vitreous Detachment (PVD)

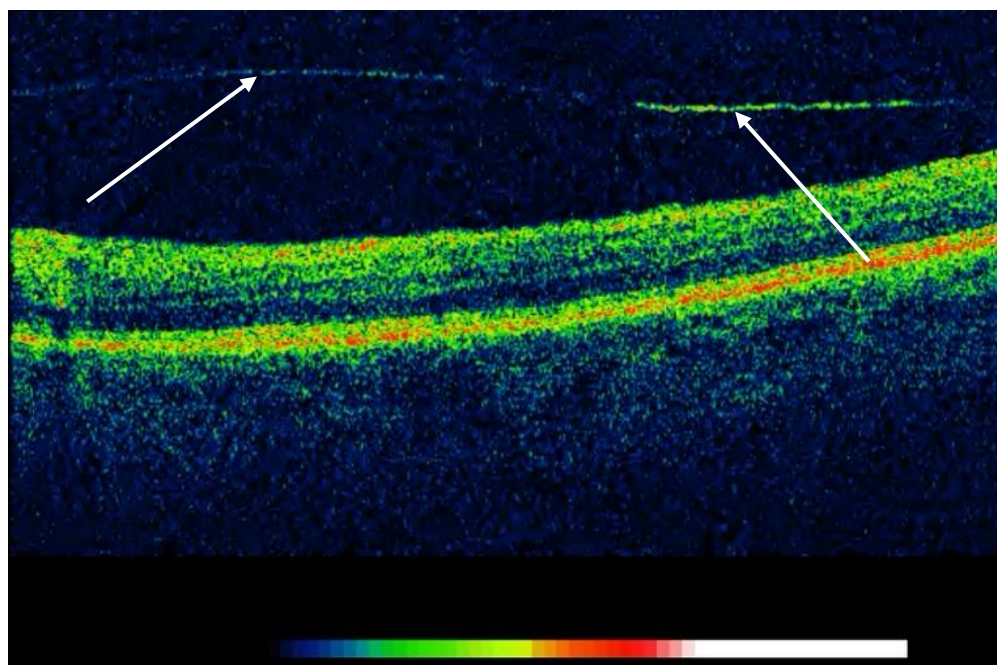


Image courtesy Dr. Lorne Yudcovitch

Posterior vitreal detachments (PVDs) are common with increasing age, and may have accompanying retinal detachment, tears, or vitreal hemorrhaging. OCT visualization of a PVD manifests as an isolated or partly detached thin fluorescent layer separated from the innermost retinal layer. They are extremely common and occurrence increases with age.

### Retinal Detachment

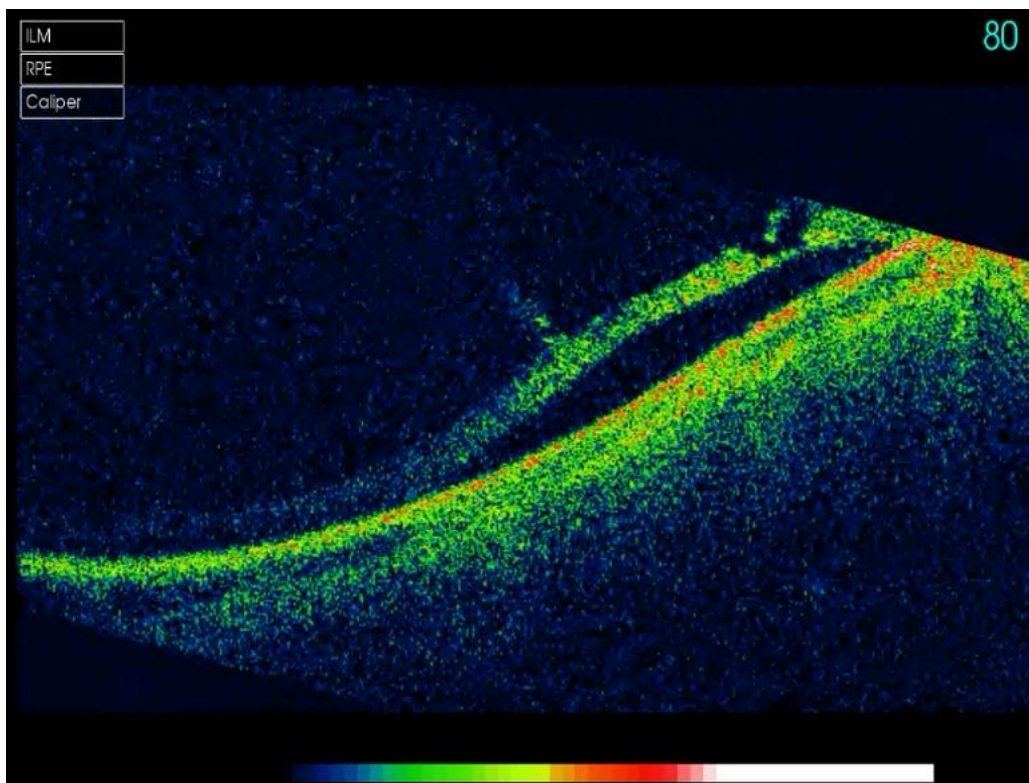
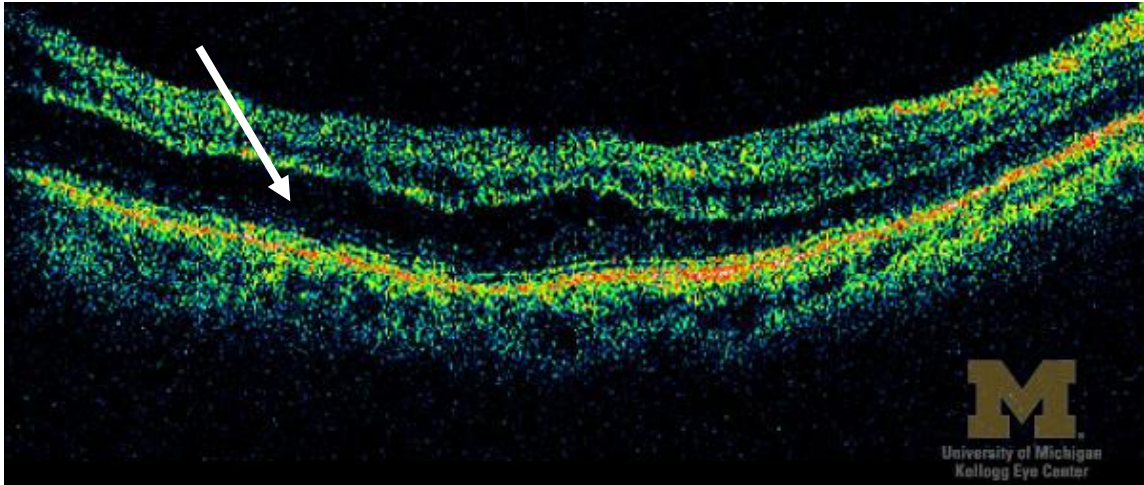


Image courtesy Dr. Lorne Yudcovitch

Retinal detachments (RDs) are of two varieties: rhegmatogenous (arising from a tear in the retina) and serous (arising from fluid leakage under the retina without a break in the retinal tissue). OCT imaging permits differentiation between the two types of RDs as well as a detailed analysis of the severity and extent of the detachment.



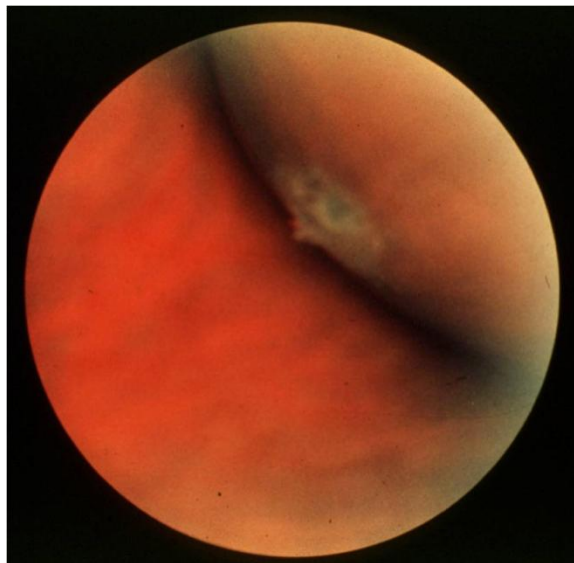
## Retinoschisis



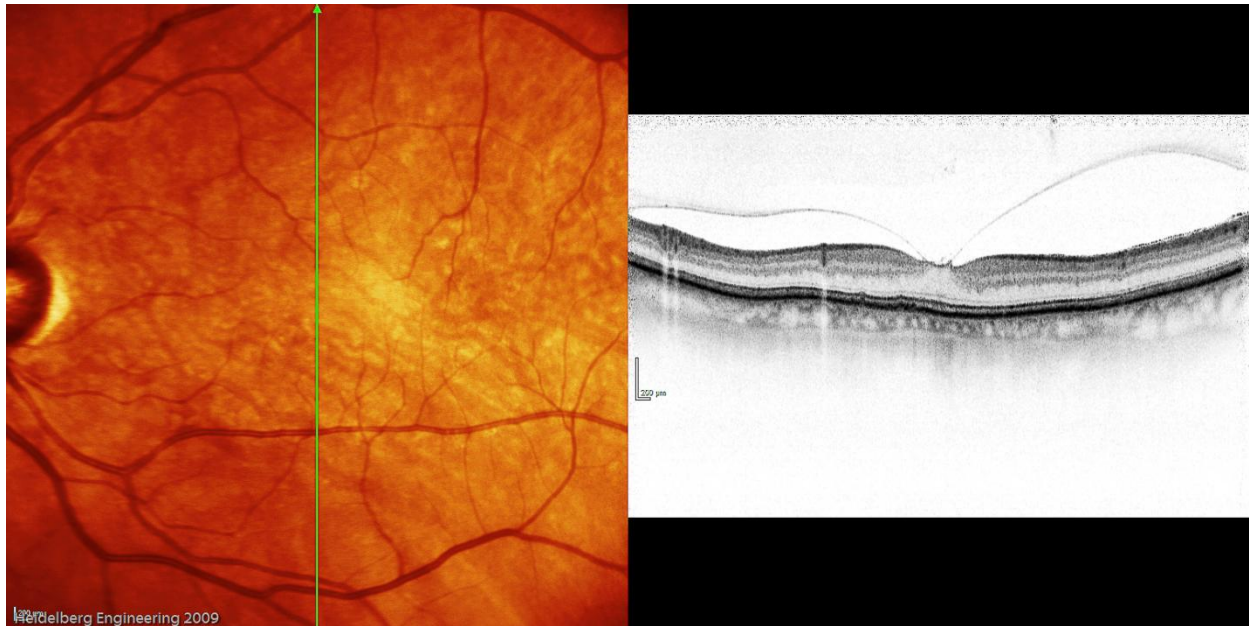
[http://www.kellogg.umich.edu/retinadx/retina\\_cases/149/photos.html](http://www.kellogg.umich.edu/retinadx/retina_cases/149/photos.html)

Retinoschisis manifests as a sharply demarcated separation between middle retinal layers on OCT imaging. It is important to differentiate acquired retinoschisis from retinal breaks or detachments (RDs) between the photoreceptor and RPE layers. Retinoschisis is generally non-progressive, with an accompanying absolute scotoma on visual field testing, whereas RDs or tears may be progressive and, when relatively new, often manifest as relative rather than absolute visual field defects.

## Vitroretinal Tuft



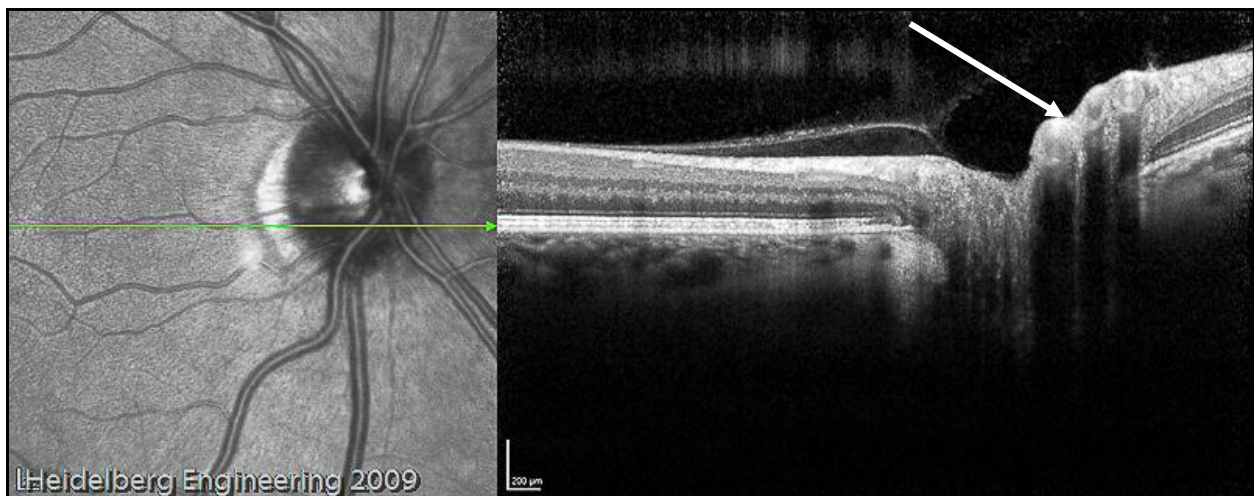
"The Peripheral Retina in Profile" Criterion Press. Copyright 1982



<http://www.retinarevealed.com/>

A vitreoretinal (V-R) tuft is generally gray-white in appearance and found in the peripheral retina. Their origin is usually proliferated glial cells or degenerated retinal cells. They can potentially cause a retinal detachment due to the fact that they can act as focal areas of increased vitreoretinal traction. It is easy to see that pulling on one central location of the retina is potentially more hazardous than over a larger area.

### Peripapillary Atrophy



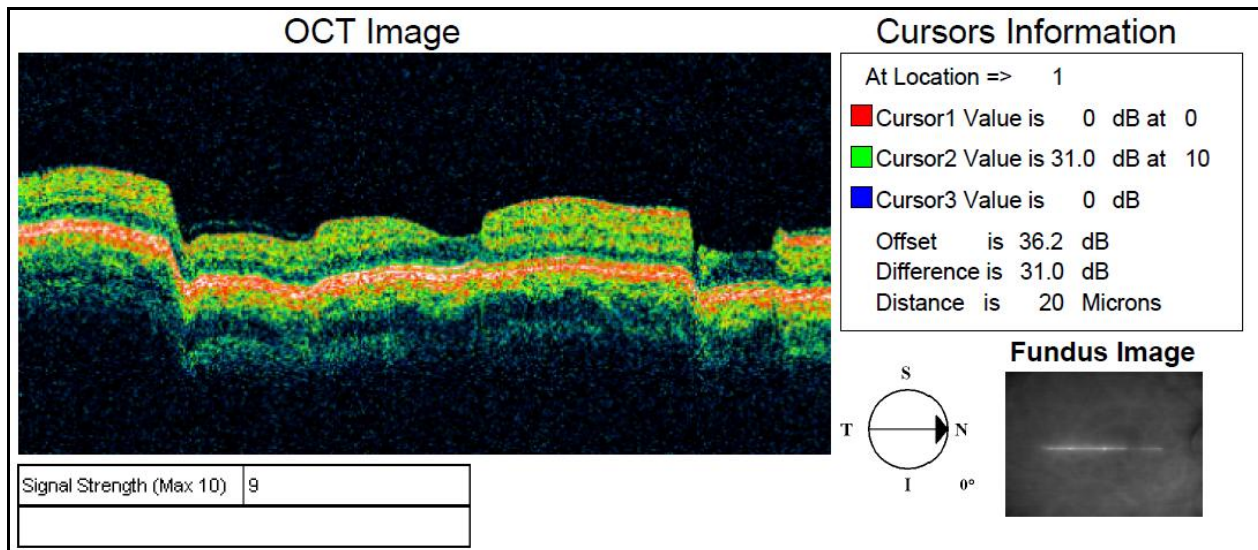
<http://www.retinarevealed.com/>

Peripapillary atrophy (PPA) appears as a mottled area adjacent to the optic disc on fundus examination. It is most commonly found in advanced glaucoma and high myopia. OCT imaging of PPA manifests as a disruption in the outer retinal layers.



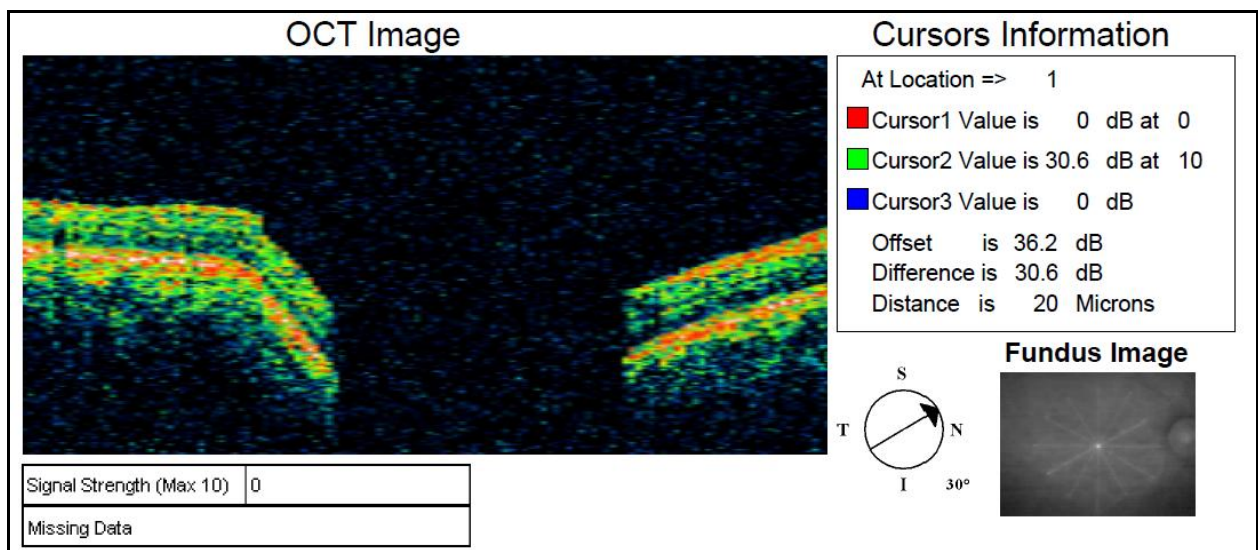
## Section 2: Common Artifacts of OCT Images

### Head Movement



Head movement is a common artifact seen on OCT images that results in a wavelike appearance to the retinal layers. The key differential between head movement artifacts and disease conditions such as epiretinal membranes is the number of retinal layers involved. Head movement will involve all retinal layers, whereas an epiretinal membrane manifests as a disruption to the inner layers only.

### Blink

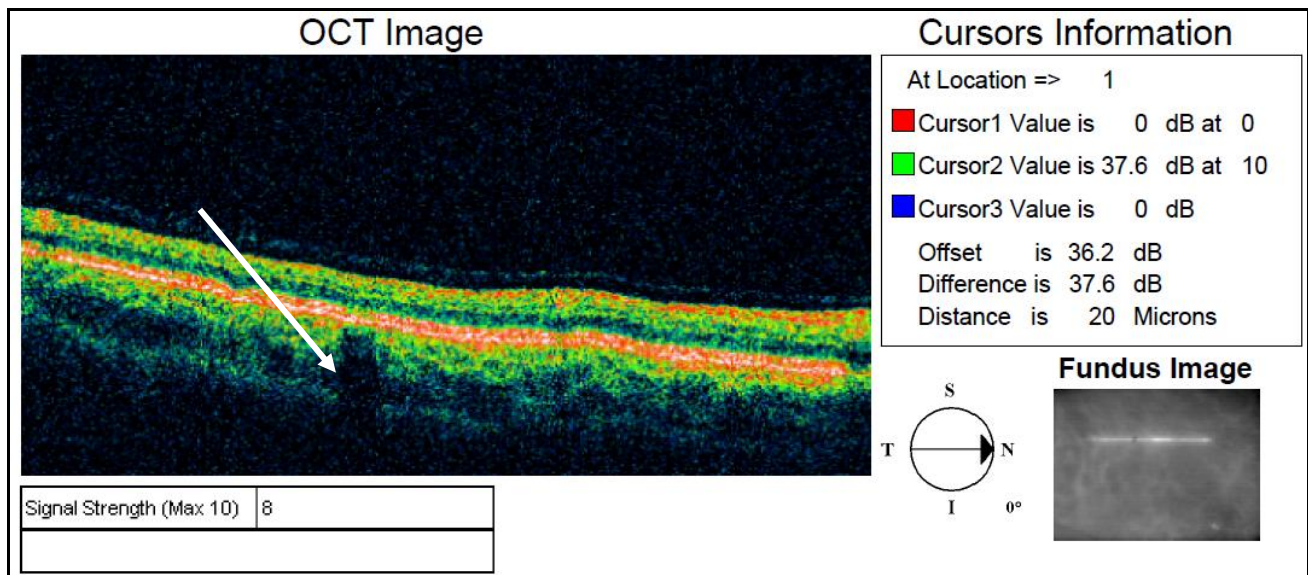




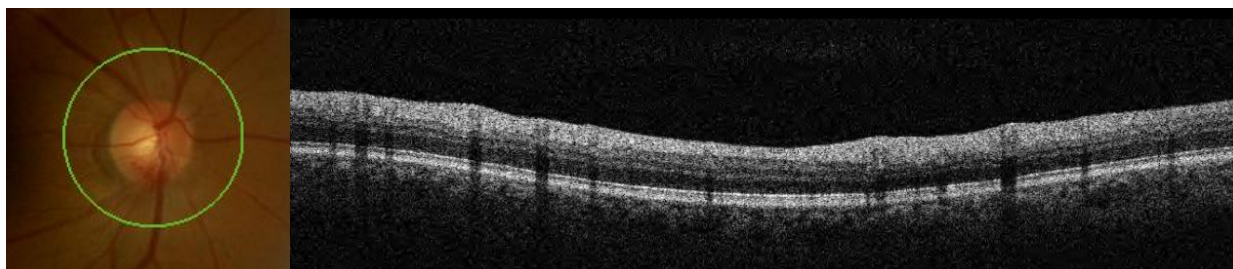
Blink artifacts are commonly seen when OCT images are taken without proper patient instruction. Blink artifacts appear as sharply defined disappearances in the retinal image layers, with all image layers being affected.

## Shadows

Certain ocular components that absorb light may cause optical shadowing of the outer tissues on an OCT image. This is commonly seen with vitreal floaters, congenital hypertrophy of the RPE (CHRPE) and prominent retinal vasculature. It is important to differentiate this shadowing effect from actual disruption of the tissues. In the case of vitreal floaters, additional imaging may be necessary to rule out other causes; in most other instances, comparison of the OCT image to a fundus photograph may help to identify benign components of the retina that are the cause of the optical shadowing.



Shadow due to CHRPE



Images courtesy Dr. Lorne Yudcovitch

Shadows due to blood vessels will appear as vertically elongated “black bars” (or sometimes white on a grayscale OCT image) that transverse multiple layers. Blood vessels are found in the nerve fiber layer (NFL) of the retina. As light enters the eye it will cast a shadow of the vessels on structures more outer to the NFL.

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This basic guide focused on the use of OCT for evaluating various retinal structures and pathologies. OCT is also used in retinal nerve fiber layer thickness (RNFL) analysis for glaucoma and other optic nerve disease, as well as anterior segment OCT evaluation for contact lens, cornea, aqueous, angle, iris, ciliary body, and lens anatomy.